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ABUNDANCE AND DISTRIBUTION OF OVERWINTERING PASSERINES IN BOTTOMLAND HARDWOOD FORESTS IN NORTH CAROLINA

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Abstract.—We investigated the abundance and distribution of passerines overwintering in natural levees, and tupelo (*Nyssa aquatica*) and cypress (*Taxodium distichum*) swamps along Roanoke River bottomland hardwood forests, North Carolina, in 1991–93. A total of 21 species, 10 resident and the remaining temperate migrants, was recorded during the study. The mean number of passerines was significantly higher ($P < 0.05$) in levee than in swamps. Resident species were significantly ($P < 0.05$) more abundant than temperate migrants within and between levees and swamps. Plant species richness and low vegetation components (e.g., horizontal cover, density of seedling/saplings) accounted for significant proportions of the variability in bird abundance within and across vegetation types. Canopy cover and density of overstory trees also predicted bird abundance, particularly for nuthatches in swamps. *Received 1 Nov. 1994, accepted 20 May 1995.*

Habitat loss and declines in abundance of some resident bird species and temperate migrants have focused attention on the need for knowledge of their overwintering ecological requirements to address year round conservation needs (Hunter et al. 1993, in press). Unfortunately, such information is limited (e.g., Dickson 1974; Root 1975; Kennedy 1977; Yahner 1985; Morrison et al. 1985, 1986; Remsen et al. 1989).

Previous studies have reported diverse breeding and overwintering bird communities in forested wetlands (Dickson 1978, Blem and Blem 1975, Kennedy 1977, Hamel 1989). However, because data on avian winter ecology in this habitat are scant, the importance of forested wetlands to resident species and temperate migrant abundance, survival and breeding success may be underestimated. A similar possibility has been noted for wintering habitats of neotropical migrants (Petit et al. 1993). Here data are presented on species composition, abundance, and distribution of overwintering Passeriformes (passerines) in natural levee and tupelo-cypress swamp forests along the Roanoke River Floodplain, North Carolina. The Roanoke River Floodplain includes the largest intact, and least disturbed, bottomland forest remaining in the Mid-Atlantic Region (Stolzenburg 1993). Relationships between passerine abundance and vegetation structural diversity were examined, and discussed in light of present management practices.

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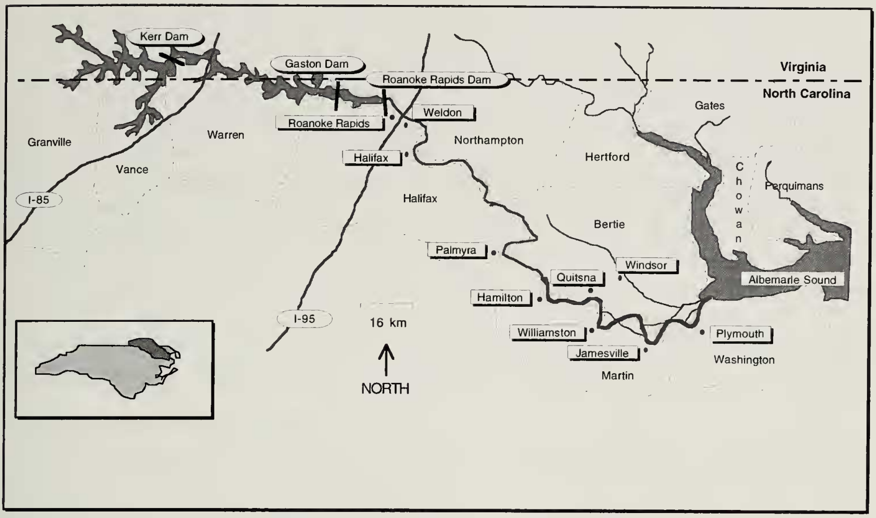

FIG. 1. Map of the lower Roanoke River Floodplain, North Carolina.

STUDY AREA AND METHODS

The Roanoke River Floodplain is approximately 354 km long and drains approximately 24,800 km^2 (Lea 1991) (Fig. 1). Three dams were built on the Roanoke River near the Virginia-North Carolina state line between 1950 and 1963 for hydroelectric power and flood control. Vegetation in the floodplain has been categorized into 20 different community types (Schafale and Weakley 1990). Tupelo-cypress dominated swamps and natural levees were selected for this study because they represent the most extensive vegetation types in the floodplain, and hence, an appropriate benchmark to develop baseline data. The tupelo-cypress swamps in this region are generally flooded for substantial parts of the year (e.g., 1–3 mo.) (Schafale and Weakley 1990). Natural levee communities occur adjacent to the river channel and are dominated by common bottomland hardwood species [e.g., box elder (*Acer negundo*), sweetgum (*Liquidambar styraciflua*), and green ash (*Fraxinus pennsylvanica*)]. Levees are seasonally to intermittently flooded during winter and spring.

Temperate migrants were defined as North American breeding species migrating within the North American continent, north of Mexico (Hunter et al. 1993), and include the Roanoke River as part of their wintering range. Permanent residents were those species present along the Roanoke year round. Their populations were censused using the fixed radius point count method (Hutto et al. 1986). Census data were collected along four (1991–92) and 16 (1992–93) transects, equally allocated between natural levee and tupelo-cypress study areas (i.e., forest tracks), and at least 150 m from any edges (e.g., river bank, plant community types). Each transect had four (1991–92) and three (1992–93) count stations placed at 150 m intervals. Data from one swamp transect (1992–93) were later discarded from analyses because the vegetation features on this transect were more characteristic of a levee-swamp ecotone. Study areas were established between Halifax and Jamesville, North Carolina, downstream from the dams (Fig. 1). Study areas in swamps ranged in size from 340 to 2500 ha; in natural levees, they ranged from 70 to 200 ha.

Biweekly counts, at each transect, were made when possible from mid-December through the end of February, 1991–1992. In 1991–92, counts were scheduled twice weekly. However, actual total visits to each transect ranged from 12 to 15 due to unexpected flooding conditions. A total of seven visits were made in 1992–93, every two weeks on the average. At each station, birds were counted for 10 min and individuals identified to species by call or sight. All detections were recorded as either inside or outside a 30-m radius (Anderson and Ohmart 1981, Blondel et al. 1981). To minimize duplicate counts, we recorded approximate position and direction of detections on station diagrams divided into quadrants along cardinal axes. Individuals flushed from within the station radius, as we approached each count station, were recorded as inside detections (Hutto et al. 1986). To complete censusing all transects within 2–4 days, count stations were visited from 07:00 and 15:30 h in 1991–92 and 07:00 through 13:00 h in 1992–93. Analyses of 1991–92 data showed that there were no significant differences in the number of detections due to time of day for 75% of the passerines (Zeller 1994). To minimize bias for species with time of day dependence and also to minimize observer biases, starting times and observers were alternated among transects and vegetation types.

Vegetation at each station was sampled in 1992–93 following procedures described by Martin and Geupel (1993). Four subpoints were established at each count station. The first subpoint was centered at the count station (marked by a stake) and the three remaining ones were located at 120° from each other around the central subpoint. The direction of the first outer subpoint was randomly located (e.g., 0–359°). The center of the outer subpoints was located 25 m from the count station center. Canopy height was measured at each subpoint using a clinometer, and vegetation was categorized as (1) all shrubs and saplings (<10 cm dbh) within a 5 m radius circle, and (2) all trees (≥10 cm) within an 11.3 m radius circle. In addition, vegetation data were grouped by timber-size classes: 1) stem (<2 cm dbh); 2) seedling/sapling (2–12 cm); (3) pole (13–27 cm); (4) small saw (28–37 cm); and (5) large saw (≥38 cm). Vegetative cover (i.e., horizontal and canopy cover) was estimated using ocular tubes (James and Shugart 1970). Readings were made at all subpoints. Horizontal cover readings were taken in each of the four cardinal directions (N, S, E, W) within a 30 m radius from the subpoint centers at hip level (approx. 0.60 m). Positive horizontal readings were recorded as either woody or herbaceous vegetation. Canopy cover was recorded at four 5 m intervals between the center and each of the 3 outer subpoints.

Although census data were collected on all passerines, blackbirds (i.e., grackles, cowbirds, starlings) were deleted from the data set because their presence on the study areas was erratic, consisting of large flocks (1,000's of individuals). Crows were also deleted because many detections were outside the areas of interest. Census data were expressed as mean total detections per count station. Total detections for a given census occasion was the sum of counts inside 30 m, outside, and flushed. Standard errors were estimated using station means, not weekly counts per station, to avoid bias caused by repeated measures (Hurlbert 1984). Total detections were used for the analyses because they met assumptions of normality and homogeneity of variances (Shapiro-Wilk and Bartlett tests, JMP, SAS Inc. 1994). Count data within 30 m were non-normal, skewed towards zero. Avian abundance levels and vegetation structural parameters between vegetation community types were compared using *t*-tests. Tests comparing abundance between vegetation community types were conducted only if a bird species was noted in both habitat types. Backward stepwise regression analyses on non-transformed habitat variables were used to identify vegetation variables related to abundance levels of passerines, and to selected resident and migrant species for which model assumptions (i.e., normality) were met using 1992–93 data. The P value to remove a variable was 0.1 (SYSTAT Inc. 1992). To minimize problems associated with multicollinearity (Neter and Wasserman 1974), we used a minimum tolerance of 0.01 (SYSTAT Inc. 1992). All tests were considered significant at an alpha of ≤0.05.

RESULTS

A total of 21 passerine species was detected during the study (Table 1). Of these, 11 were residents and the rest temperate migrants. Blue Jays, Carolina Chickadees, Carolina Wrens, Ruby-crowned Kinglets, Northern Cardinals, and White-throated Sparrows were detected in greater numbers in levees than in swamps during both field seasons. Brown Thrashers, Rufous-sided Towhees and Hermit Thrushes were detected only in levees. Cedar Waxwings, Yellow-rumped Warblers and American Goldfinches were detected only in levees in 1992. Similarly, Eastern Phoebes and Eastern Bluebirds were detected only in swamps that year. Only the White-breasted Nuthatch had significantly greater abundance in swamps than in levees both seasons (Table 1).

Mean number of passerines in levees was significantly higher than in swamps each year (91–92: t = 4.96, df = 14; 92–93: t = 4.60, df = 43) (Table 2). We also detected significantly more resident species and temperate migrants in levees than in swamps each year. Within levees or swamps, we detected significantly more resident species than migrants in both years. In swamps, mean passerine counts were significantly greater in 1992–93 than in 1991–92 (t = 4.74, df = 27). Mean passerine counts did not differ significantly between years in levees.

Levees had significantly higher plant species richness, herbaceous cover, and stem density than swamps (Table 3). In contrast, swamps had significantly greater densities of pole (13–27 cm), small saw (28–37 cm), and large saw timber ($\geq$38 cm). Passerine abundance, across both levees and swamps, varied significantly with levels of horizontal cover, plant richness, and negatively with small saw timber (F = 16.60, df = 3, 41). Within levees, abundance of passerines was significantly and positively related to levels of horizontal cover, whereas, in swamps, it was positively related to density of small saw timber and canopy cover (Table 4). The abundance of Carolina Chickadees in levees was positively related to density of seedling/saplings and pole timber; in swamps their abundance was negatively related to density of seedling/saplings. The abundance of Tufted Titmice and Carolina Wrens was primarily related to low vegetation components (e.g., horizontal cover, seedling/saplings) (Table 4). The abundance of the White-breasted Nuthatch was negatively related to density of pole timber in levees and positively to small saw timber in swamps. The abundance of Golden-crowned Kinglets was positively related to stems <2 cm diameter and seedling/saplings, both in levees and swamps, but negatively related to horizontal cover in swamps. Winter Wrens were negatively related to horizontal cover in levees and swamps, whereas, the

TABLE 1

MEAN DETECTIONS/STATION (± SE) AND BETWEEN VEGETATION COMMUNITY COMPARISONS OF OVERWINTERING RESIDENT AND TEMPERATE MIGRANT[a] SPECIES, ROANOKE RIVER, NORTH CAROLINA

	1991–1992		1992–1993	
Species	Levee	Swamp	Levee	Swamp
Eastern Phoebe (*Sayornis phoebe*)	0	0.05 ± 0.02	0.15 ± 0.03	0.25 ± 0.05
Blue Jay (*Cyanocitta cristata*)	0.19 ± 0.06	0	0.14 ± 0.06*	0.01 ± 0.01
Carolina Chickadee (*Parus carolinensis*)	1.11 ± 0.11*	0.41 ± 0.08	1.39 ± 0.10*	0.81 ± 0.09
Tufted Titmouse (*P. bicolor*)	0.35 ± 0.11	0.30 ± 0.07	0.67 ± 0.06*	0.41 ± 0.08
White-breasted Nuthatch (*Sitta carolinensis*)	0.28 ± 0.08	0.87 ± 0.03*	0.46 ± 0.07	1.71 ± 0.14*
Brown Creeper[a] (*Certhia americana*)	0.02 ± 0.01	0.06 ± 0.03	0.34 ± 0.02	0.06 ± 0.02
Carolina Wren (*Thryothorus ludovicianus*)	1.47 ± 0.09*	0.33 ± 0.04	1.88 ± 0.15*	0.71 ± 0.09
Winter Wren[a] (*Troglodytes troglodytes*)	0.14 ± 0.04	0.15 ± 0.05	0.32 ± 0.04	0.26 ± 0.05
Golden-crowned Kinglet[a] (*Regulus satrapa*)	0.08 ± 0.03	0.08 ± 0.04	0.25 ± 0.04	0.26 ± 0.05
Ruby-crowned Kinglet[a] (*R. calendula*)	0.27 ± 0.11	0	0.53 ± 0.06*	0.02 ± 0.01
Eastern Bluebird (*Sialia sialis*)	0	0.01 ± 0.01	0.04 ± 0.02	0.12 ± 0.05
Hermit Thrush[a] (*Catharus guttatus*)	0.04 ± 0.01	0	0.35 ± 0.08	0
American Robin[a] (*Turdus migratorius*)	0.81 ± 0.70	0	0.24 ± 0.06	0.15 ± 0.04
Brown Thrasher (*Toxostoma rufum*)	0.02 ± 0.02	0	0.01 ± 0.01	0
Cedar Waxwing[a] (*Bombycilla cedrorum*)	0.06 ± 0.04	0.01 ± 0.01	0.15 ± 0.09	0.05 ± 0.03
Yellow-rumped Warbler[a] (*Dendroica coronata*)	0.14 ± 0.05	0	0.18 ± 0.04	0.12 ± 0.03
Northern Cardinal (*Cardinalis cardinalis*)	0.33 ± 0.11*	0.01 ± 0.01	0.44 ± 0.10*	0.03 ± 0.02
Rufous-sided Towhee (*Pipilo erythrophthalmus*)	0	0	0.05 ± 0.03	0
Fox Sparrow[a] (*Passerella iliaca*)	0.02 ± 0.02	0	0	0.01 ± 0.01
White-throated Sparrow[a] (*Zonotrichia albicollis*)	0.58 ± 0.11	0	0.20 ± 0.07*	0.01 ± 0.01

TABLE 1
CONTINUED

Species	1991–1992		1992–1993	
	Levee	Swamp	Levee	Swamp
American Goldfinch (*Carduelis tristis*)	0.14 ± 0.06	0	0.18 ± 0.04	0.08 ± 0.02

Asterisk indicates significant ($P < 0.05$) differences within years, t-tests.

abundance of Yellow-rumped Warblers was related to large saw timber in levees and negatively to canopy cover in swamps (Table 4).

DISCUSSION

Most passerine species, irrespective of their migratory status, were more abundant in natural levees than in swamps. Similar results were reported by Dickson (1974) and Kennedy (1977) for other bottomland forests in southeastern United States. Kennedy (1977) compared overwintering passerine abundance between swamps and forest tracks similar in plant composition to levees in our study. He reported significantly higher abundance for 8 of 11 species found to be significantly more abundant in levees in this study. Mean annual counts for passerines were significantly different in swamps, but not in levees. Determining the underlying causes for the observed interannual variability was beyond the scope of this study. Possible explanations include annual variations in population numbers, either locally or regionally; changes in habitat structure or food availability; or flood conditions. We measured and documented seasonal flood fluctuations in 1992–93, but they did not influence avian abundance fluctuations that year (Zeller 1994). We believe, however, that observer bias and differences in species detectability (Shields

TABLE 2
MEAN DETECTIONS/STATIONS (± SE) AND COMPARISONS BETWEEN VEGETATION COMMUNITY TYPES OF OVERWINTERING PASSERINE SPECIES ALONG THE ROANOKE RIVER, NORTH CAROLINA

Species group	1991–1992		1992–1993	
	Levee	Swamp	Levee	Swamp
Passerine community[a]	6.03 ± 0.66*	2.27 ± 0.19	7.68 ± 0.44*	5.07 ± 0.35
Resident species	3.88 ± 0.25*	1.98 ± 0.17	5.42 ± 0.31*	4.14 ± 0.29
Temperate migrant	2.15 ± 0.64*	0.29 ± 0.06	2.26 ± 0.20*	0.93 ± 0.12

[a] Passerine community does not include crows, grackles, cowbirds or starlings.
Asterisk indicates significant ($P < 0.05$) differences within years, t-tests.

TABLE 3

COMPARISONS OF WINTER STRUCTURAL VARIABLES (± SE) BETWEEN NATURAL LEVEE AND SWAMP VEGETATION COMMUNITIES ALONG THE ROANOKE RIVER, NORTH CAROLINA

Structural variable	Levee	Swamp
Canopy height (m)	27.80 ± 0.56	26.33 ± 0.88
Canopy cover	0.78 ± 0.02	0.75 ± 0.02
Plant species richness (mean no. sp.)	17.50 ± 0.45*	7.80 ± 0.32
Horizontal cover (wood and herbaceous)	0.82 ± 0.04	0.75 ± 0.03
Woody cover	0.63 ± 0.05	0.73 ± 0.03
Herbaceous cover	0.19 ± 0.05*	0.02 ± 0.01
Stem counts (mean/0.04 ha)		
<2 cm diameter	125.46 ± 21.08*	11.66 ± 2.99
Seedlings/saplings (2–12 cm dbh)	12.96 ± 1.16	10.12 ± 2.21
Pole timber (13–27 cm dbh)	7.55 ± 0.48	11.46 ± 7.40*
Small saw timber (28–37 cm dbh)	3.04 ± 0.28	4.62 ± 0.63*
Large saw timber (≥38 cm dbh)	4.48 ± 0.17	10.63 ± 0.70*

Asterisk indicates a significant difference, *t*-tests ($P < 0.05$).

TABLE 4

STRUCTURAL VARIABLES IDENTIFIED AS SIGNIFICANT PREDICTORS ($P < 0.05$) OF ABUNDANCE FOR OVERWINTERING PASSERINES AND SELECTED RESIDENT AND TEMPERATE MIGRANT SPECIES[a] WITHIN VEGETATION COMMUNITIES ALONG THE ROANOKE RIVER, NORTH CAROLINA (1992–1993)

	Levee		Swamp	
	Variable	r^2	Variable	r^2
Passerines	Horizontal cover	0.54	Canopy cover Small saw timber	0.46
Carolina Chickadee	Seedlings/saplings Pole timber	0.32	Seedlings/saplings*	0.17
Tufted Titmouse	Horizontal cover	0.16	Seedlings/saplings*	0.21
White-breasted Nuthatch	Pole timber*	0.20	Small saw timber	0.44
Carolina Wren	Horizontal cover Large saw timber*	0.27	Horizontal cover	0.31
Winter Wren[b]	Horizontal cover*	0.21	Horizontal cover*	0.11
Golden-crowned[b] Kinglet	Stem <2 cm diam. Seedlings/saplings	0.33	Horizontal cover* Stem <2 cm diam.	0.56
Yellow-rumped[b] Warbler	Large saw timber	0.16	Canopy cover*	0.22

[a] Asterisk indicates a significant negative relationship with abundance.
[b] Migrant species.

1979) were not determining factors influencing interannual variability in swamps because abundance levels in levees were similar between years and avian composition in both vegetation community types and years was the same.

Numerous authors have documented the relationship among plant species richness and structural diversity, and bird abundance (e.g., Recher 1969, Barrow 1990). In this study, variability in passerine abundance across vegetation community types was positively related to horizontal cover (index to understory structural complexity), higher plant species richness, and lower density of small saw timber. Low vegetation features (e.g., stems <2 cm, seedling/saplings) were prevalent in levees, where abundance levels were higher for most species. Within vegetation community types, understory and midstory components (e.g., horizontal cover, seedlings/saplings) accounted for significant proportions of the variability in abundance of nearly every selected species, except for the White-breasted Nuthatch and Yellow-rumped Warbler. The abundance of these species was better predicted by overstory components (e.g., saw timber). Vegetation components identified in our analyses are also among the substrates used during winter (e.g., foraging, resting) by the selected species (Hamel et al. 1982). For instance, Carolina and Winter Wrens are typically associated with mid- and understory vegetation. Vegetation components in these layers emerged as predictors of their abundance. White-breasted Nuthatches are associated primarily with the overstory layer. A major contributor to this layer is saw timber, a major component of swamps where nuthatches were significantly more abundant. Canopy cover, another predictor of abundance in the analyses, probably plays a role in providing protection from wind and precipitation (Morrison et al. 1986).

Hunter (in press) emphasized the need to redirect some conservation efforts towards resident species and temperate migrants, particularly in habitats experiencing high loss rates such as bottomland forests. Data on species-habitat relationships, such as those presented here, are necessary to begin to understand the causal relationships between vegetation changes on wintering grounds and breeding populations (see Petit et al. 1993). Avian conservation strategies in the Roanoke River Floodplain need to be formulated paying particular attention to silviculture and dam operations. We think that management practices outlined by Pashley and Barrow (1993) are adequate to maintain vegetation components identified in this study. Of major concern from a conservation perspective in the Roanoke is the altered and unpredictable flow regimes caused by flood control structures and power generating facilities (Schneider et al. 1989). Dam-regulated rivers could impact the availability of vegetation features influencing abundance and distribution of overwintering passerines by affecting regeneration and species pioneering processes, as well as growth conditions (Sharitz and Lee 1985, Schneider and Sharitz 1986, Schneider et al. 1989). These studies suggest that, in the long-term, the Roanoke River's altered flooding regime is likely to create larger, less diverse areas of low elevation forest (i.e., swamps), which were found to attract fewer numbers of overwintering passerines. Due to the potential floodplain-wide effects on avian abundance and distribution, changes in vegetation structure as a function of altered flooding patterns need to be studied. Until more specific vegetation requirement data are available, we favor maintaining diverse vegetation communities in bottomland forests as recommended by Barrow (1990) and Pashley and Barrow (1993). This approach also accommodates the need to manage for year round avian vegetative requirements (i.e., breeding birds).

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WATERBIRDS, WETLANDS AND RECREATION: PUTTING SUSTAINABILITY INTO PRACTICE

An international conference jointly organized by British Ornithologists' Union & The Wildfowl & Wetlands Trust

Recreation on and around wetlands is now more widespread and intensive than ever before, to the extent that it is often the principal threat to their conservation value. Increasing human populations and/or affluence in many countries can only mean that this problem will increase. To achieve sustainability, recreational needs have to be integrated into the conservation of biodiversity. The aim of this international conference is to synthesize the current scientific understanding of the effects of recreational activities e.g., hunting, fishing, watersports and informal recreation) on wetlands, to formulate solutions to specific problems and to condsider how these may be consolidated within wider ecosystem management activities. In addition to the production of a scientific proceedings, the aim is to produce a practitioners guide to sustainable recreation on and around wetlands. The conference will be held at Wills Hall, Bristol, UK, from 19–21 April 1996. Offers of abstracts for posters and papers should not exceed 400 words and should be sent to: **Jeff Kirby, The Wildfowl & Wetlands Trust, Slimbridge, Gloucester, GL2 7BT, UK.** Booking enquiries should be sent to: **Graeme Greene, British Ornithologists' Union, % British Museum (Natural History), Subdepartment of Ornithology, Tring, Hertfordshire, HP23 6AP, UK.**